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Do private standards create exclusive supply chains? New evidence from the Peruvian asparagus export sector

Monica Schuster *, Miet Maertens

Division of Bioeconomics, Department of Earth and Environmental Sciences, KU Leuven, Belgium

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ABSTRACT

Developing countries are increasingly exporting fresh horticultural products to high-income countries. These exports increasingly have to comply with stringent public and private standards, as well as other quality and safety issues. There is an ongoing debate on the effect of private standards on the inclusion of small-scale farmers in export supply chains. With this paper, we contribute to this debate by providing new evidence from the Peruvian asparagus export sector, and by addressing several important methodological shortcomings and gaps in the existing literature. We describe export dynamics using a unique firm level dataset on 567 asparagus export firms from 1993 to 2011 and the evolution of certification to private standards using own survey data from a stratified random sample of 87 export firms. We use an unbalanced panel of the surveyed companies on 19 years and several methods, including fixed effects and GMM estimators, to estimate the causal impact of certification to private standards on companies' sourcing strategy. We find that certification leads to vertical integration and significantly reduces the share of produce that is sourced from external producers, with a larger effect for small-scale producers. When distinguishing between production and processing standards, and between low-level and high-level standards, we find that especially high-level production standards have a negative impact on sourcing from (small-scale) producers.

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Introduction

Standards are increasingly governing international food production and trade. While public standards, set by public authorities, mainly focus on food quality and safety issues, private standards, set by private companies and non-state actors often add other aspects such as ethical or environmental concerns. Private standards started to emerge at the end of the 1990s, mainly in response to consumer concerns in high-income countries about food safety and quality. The spread of private standards has been intensively documented in the literature (e.g. Henson and Reardon, 2005; Humphrey, 2008; Jaffee, 2003). Due to the expansion of agricultural trade between industrialized and developing countries, private standards have quickly become a global phenomenon, influencing developing countries' markets and producers (Jaffee and Masakure, 2005; Reardon et al., 2001; Unnevehr, 2000). The private nature of these standards creates a non-regulated area that goes beyond the competence of national authorities and opens up new debates on the legal dimensions as well as on the development impacts of private standards (Marx et al., 2012).

A major concern is that standards engender an unequal distribution of the gains from trade because they lead to the exclusion of the least developed countries and the poorest farmers, who are unable to comply with stringent requirements due to a lack of technical and financial capacity (Graffham et al., 2007; Maertens and Swinnen, 2007; Reardon et al., 2001 or Swinnen and Vandeplas, 2011; Vandemoortele et al., 2012 for theoretical notes). There is a stream of empirical literature that focuses on the impact of private standards on export volumes, either at the country level (e.g. Anders and Caswell, 2009; Jongwanich, 2009; Wilson et al., 2003; Wilson and Otsuki, 2003) or at the individual firm level (e.g. Schuster and Maertens, 2013). A second stream of studies – to which this paper will contribute – is addressing the issue of inclusion or exclusion of smallholder and family farms as a result of increasing standards (e.g. Henson et al., 2005; Maertens and Swinnen, 2009; Reardon et al., 2009). Several studies have documented that with increasing standards, a decreasing share of export produce is sourced from small farmers. For example, Maertens and Swinnen (2009) document a recent shift from smallholder contract farming to vertically integrated farming on large-scale plantations in the vegetable export sector in Senegal and attribute this shift to the increased importance of standards. Gibbon (2003) observes that increased exports of fresh produce from developing countries is generally accompanied by a decline in the proportion of this

* Corresponding author. Address: Celestijnenlaan 200E, 3001 Leuven, Belgium. Tel.: +32 16 329722.
E-mail address: monica.schuster@ees.kuleuven.be (M. Schuster).

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produce accounted for by smaller-scale producers. Several authors, based on diverse empirical case-studies, have indicated that the inclusion of family-type farms in high-standard trade and the adoption of high standards by smallholder farms is only possible through external interventions, e.g. development programs, public–private partnerships or collective action support (e.g. Boselie et al., 2003; Kersting and Wollni, 2012; Narrod et al., 2009; and Okello et al., 2011). Blandon et al. (2009) indicate that producers' traditional marketing preferences could impede them to participate in emerging supply chains, characterized by growing quality requirements, and thus to take advantage of the potential opportunities the modern chains offer. Contrariwise, a recent study on African exporters by Henson et al. (2013) points to a complementary rather than a competitive relationship between company own-farm production and sourcing from smallholder farmers. Maertens et al. (2012) provide a review of the literature on smallholder inclusion/exclusion in high-standards horticultural export chains in Africa. They conclude that the evidence is mixed, and that in some sectors and countries standards have led to increased exclusion of smallholder farms while in other sectors and countries high-standards exports are largely realized by smallholder farmers.

With this paper, we contribute to this stream of empirical literature with a specific case-study and address several important shortcomings and gaps in the existing studies. First, despite a large body of literature on the participation of small producers in modernizing supply chains, remarkably few studies provide quantitative evidence on the impact of standards. To the best of our knowledge, no study has been able to effectively disentangle the role of private food standards from a general trend of modernizing value chains. Second, most studies focus on smallholder producers and compare included versus excluded producers (e.g., Asfaw et al., 2010; Chemnitz, 2007; Mausch et al., 2009; Subervie and Vagneron, 2013). This approach is useful to understand which farmers are excluded/included and address issues of inequality but complicates the identification of a causal link between private standards and exclusion. Third, most studies use cross sectional farm data. With such data it is impossible to look at dynamic trends, and difficult to control for selection bias and unobserved heterogeneity to accurately estimate the effect of standards. Fourth, another limitation in the existing literature is that surprisingly little attention is given to the multiple scopes and types of private standard. The existing literature either considers private standards as a homogenous whole or focuses on specific main standards only (e.g. Henson et al., 2011; Kersting and Wollni, 2012; and Lemeilleur, 2012 focus on Global Gap only; Herzfeld et al., 2011 focus on BRC and Global Gap). Yet, private standards are diverse (Humphrey, 2011). They can apply to food processing and post farm-gate processes only (i.e. HACCP, BRC, IFS etc.) or be concerned with farm-level production (i.e. GAP, Global Gap, Tesco etc.). Some standards only cover basic requirements, while others are more stringent.

The objective of this paper is to estimate the impact of certification to private standards on the strategy of export companies[1] to source from external producers and small-scale farmers or to vertically integrate. We focus on the Peruvian asparagus export sector and provide empirical panel data evidence at the level of export companies. The sector represents a unique case study from a scientific perspective, due to the size of the industry with around 100 exporting firms per year, its long history, the availability of firm longitudinal data for the period 1993–2011, as well as the diversity of adopted private standards. The availability of panel data for a large set of companies and years allows us to hold country and sector specific aspects constant, to take into account sourcing trends, to correct for unobserved heterogeneity and company self-selection into private standard schemes, and to distinguish between different types of private standards. These are important methodological improvements that allow us to more accurately estimate the impact of standards on sourcing from local and small-scale producers.

The structure of this paper is as follows: we first describe the data used for the analysis and define the firm's sampling strategy. We then provide descriptive evidence on the evolution of export quantities, the different types of private food certification schemes and the sourcing behavior of firms. Further, we define our estimation and identification strategy and report econometric results. We conclude with policy implications and future research needs.

Data

We use a unique firm level dataset on Peruvian asparagus exports constructed from secondary sources and own original data collection. The secondary data include custom records (SUNAT – Peru) at a transaction level on all fresh asparagus export transactions over the period 1993–2011. This dataset contains information on 567 fresh asparagus export firms and includes the identification of the exporter (firm names and tax identification number), the exported volume, the destination market and the FOB value for all export transactions. Since virtually the entire asparagus production in Peru is destined for export markets, the customs data comprise the entire industry sales. We merge these data with tax administration data, containing information on the foundation date of the firms, core activities, general managers, location, branches, as well as historical fiscal benefits or irregularities. When companies are not exporting in a specific year, the export data are missing while the tax administration data are available for all years in which the company is registered as being active. In our dataset all companies are considered as "exporters" from the year they first export fresh asparagus and as long as they are registered as an active company with the tax administration. We substitute zeros with missing values for export volumes and FOB values of the companies considered as "exporters".

We complement these secondary records with primary data from a survey among a representative sample of export companies. From the total population of 567 firms that at least once exported fresh asparagus between 1993 and 2011, we draw a stratified random sample of 100 companies. We randomly selected companies from three mutually exclusive strata, according to the companies exporting experience in 2011: *consolidated companies* with at least 6 years of exporting experience (total population of 63 companies), *intermediate companies*, between 3 and 5 years of exporting experience (90 companies) and *start-up companies* with less than 3 years of experiences (416 companies). Together consolidated and intermediate companies are responsible for 88% of the volumes exported between 1993 and 2011 and are more likely to be certified to private standards than start-up companies. These last companies, often only export for a few years and then withdraw from the export sector. For the analysis of dynamics in the Peruvian asparagus export sector, consolidated and intermediated companies are more relevant, and, therefore, we oversample companies in the first two strata. The sample includes both companies that were operational in 2011, the year the survey was implemented, as well as companies that ceased operations by that year. This sampling strategy ensures that the sample is representative not only for the current situation but for the whole period. The survey was implemented between July and September 2011 using an original questionnaire including recall questions on the certification to private food standards, sourcing strategies, ownership and management structure, as well as on processing and production

[1] The terms "export company" and "export firm" are used interchangeably throughout this paper.

procedures. When export volumes are zero in a specific year, the quantity sourced is set to missing. This leaves us with an unbalanced dataset but with an average of 6 time periods per company, of which 80% are consecutive (i.e., the missing observations appear only at the end of each panel's data).[2]

Descriptive statistics are partially drawn from secondary data, including the whole population of 567 companies, and partially from primary data, coming from the sample of 87 companies[3] and including 44 consolidated companies, 27 intermediate companies and 16 start-up companies. In the latter case we use sampling weights that put less weight on consolidated and intermediate companies and more weight on start-up companies to adjust for the stratified sampling design. In particular, we calculated different weights for each year of the analysis according to the number of consolidated, intermediate and start-up companies that were present in the entire population of export firms and the number of firms that we had included in our sample. Regressions are run on 84 out of the 87 surveyed companies, due to missing values in the company covariates and on 70 companies when lagged variables are used as instruments for current variables.

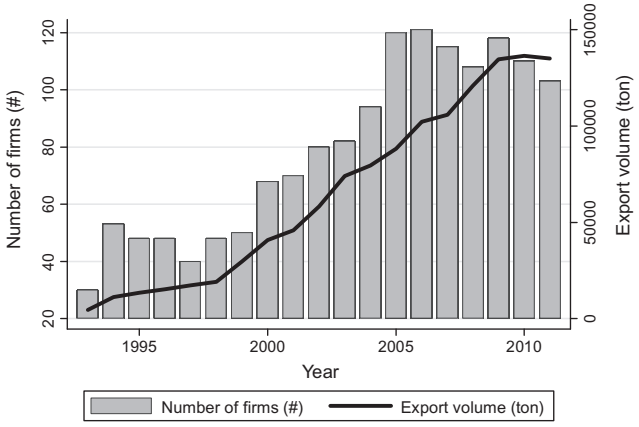
Sectoral analysis

Exports

Asparagus exports accounted for about 16% of total agricultural exports in Peru in 2011. More than 220,000 mt (metric tons) are produced yearly and practically the entire production is exported, of which 70% as fresh produce (SUNAT, 2011). This makes Peru the largest exporter of fresh asparagus worldwide. The main destination markets for fresh asparagus exports are the USA and the EU (European Union).

The history of cultivation and export of asparagus from Peru goes back to the 1950s, when imported seeds from California (USA) were first planted in La Libertad region in Northern Peru. Production and export did not expand considerably until the seeds spread to the Ica region, located south of Lima, during the mid 1980s. The sector further expanded during the 1990s and 2000s, with the sharpest growth in fresh produce exports during the early years 2000 (Fig. 1). Export growth slowed down from 2006 onwards and experienced small fluctuations in subsequent years. These export trends are likely related to a mixture of domestic policies and global market changes, such as the introduction of new neo-liberal land policies promoting private investment in agriculture in Peru (Diaz, 2007; O'Brien and Diaz, 2004; Shimizu, 2006), increasing USD/Peruvian Nuevo Sol exchange rate fluctuations,[4] shocks in international food market, and the global economic crisis.

The number of fresh asparagus export companies has evolved in a similar manner. The number has tripled from around 40 companies at the end of the 1990s to almost 120 companies in 2006, and remained at around 100 companies per year since 2006. The total number of 567 companies from the custom database that ever exported fresh asparagus since 1993 indicates a large transition in and out of exporting.



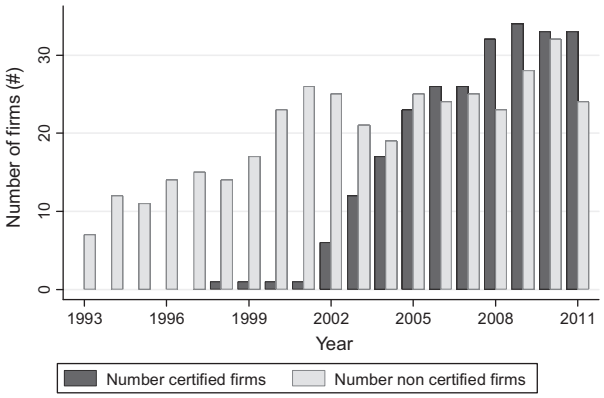
Note: Population of 567 export firms over 1993-2011
Source: Author's calculation based on SUNAT Custom data, Peru

Fig. 1. Number of export firms (left vertical axis) and evolution of export volumes (right vertical axis) for the period 1993–2011; for the population of 567 export firms.

Private standards

Private standards started to gain importance in the fresh asparagus export sector in the year 2000 and certification to these standards has spread rapidly in the sector from then onwards. Fig. 2 shows, for our 87 sampled companies, the evolution of the number of certified and non-certified companies over the period 1993–2011. While until 1998 none of the companies was certified, certification takes off from the year 2000 and since 2006 the number of certified companies exceeds that of non-certified companies.

Table 1 provides an overview of company certification to different types of private standards in 2001, the year when standards started to become relevant in the Peruvian asparagus sector, in 2006 and in 2011, the last year of observation in our dataset. Between 2001 and 2006 we witness a steep increase of the share of certified firms, from almost zero to 50% of the companies. After this first boost, the percent of certified firms reduced again, falling to 38% in 2011. The average number of certificates held by companies with at least one certificate, also increased considerably and while in 2001, no certified company complied to more than one certification scheme, in 2011, certified companies held 2.5 certificates on average. The comparison between the share of companies certified and the average number of certificates per company indicates there is a divide between the type of exporters, with some investing in multiple types of certifications and others not seeking certification at all.



Note: Sample of 87 export firms over 1993-2011
Source: Author's calculation based on SUNAT and survey data

Fig. 2. Evolution of the number of certified and non-certified export firms for the period 1993–2011; for the sample of 87 surveyed export firms.

[2] We also did the analysis of this paper by balancing the panel and replacing the variables related to sourcing strategies with zeros when a company was not exporting one year. The main results do not change. We decide to report results in which zeros refer to an actual choice of a company to produce the exported product instead of buying it from external suppliers.

[3] Due to field logistics 6 of the 100 sampled companies could not be interviewed, while 7 surveyed companies only exceptionally export fresh asparagus and are therefore dropped from the sample.

[4] The USD was historically weak as compared to the Peruvian Nuevo Sol at the end of the year 2007/beginning of 2008.

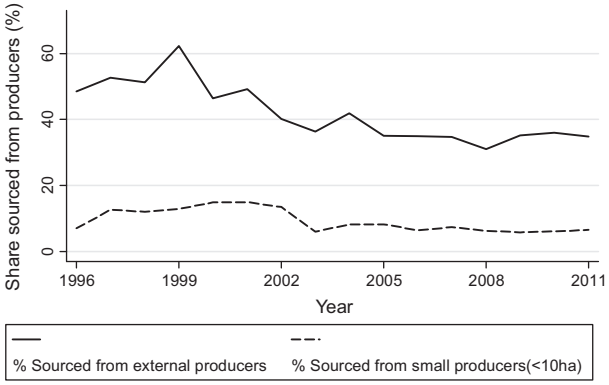
Table 1
Percentage of firms with specific certification schemes and number of certificates for certified firms (2001, 2006 and 2011). *Source:* Authors calculation based on own survey data.

Private certification scheme	Firms in 2001 ($N = 26$)	Firms in 2006 ($N = 49$)	Firms in 2011 ($N = 56$)
Certification	7.1%	49.2%	37.8%
Number of certificates for certified firms[a]	1(0.000)	1.745(0.944)	2.467(1.372)
Production certification	**0**	**44.3%**	**34.6%**
Number of production certificates for certified firms[a]	0	0.899(0.306)	1.367(0.969)
Low level production certification	*0*	*3.3%*	*3.2%*
GAP	0	1.6%	2.1%
SQF1000	0	1.6%	1.1%
High level production certification	*0*	*45%*	*34.6%*
Global Gap	0	45%	34.6%
TESCO	0	5%	6.4%
LEAF	0	0	4.3%
Processing certification	***7.1%***	**23.5%**	**25%**
Number of processing certificates for certified firms[a]	1(0.000)	0.134(0.347)	1.156(1.139)
Low level processing certification	*7.1%*	*21.9%*	*16.2%*
HACCP	3.6%	20.2%	14.1%
SQF2000	0	9.9%	7.7%
GMP	3.6%	6.6%	7.5%
High level processing certification	*0*	*6.6%*	*16.5%*
BRC	0	4.9%	15.4%
IFS	0	0	2.4%
Other			
BASC	0	14.8%	15.2%

Values in bold and italics indicate supersets of the below listed certification schemes.
[a] Count variable: the numbers represent means and standard deviations in parenthesis.

We subdivide private standards into production and processing standards and into low and high level standards (Table 1). This classification is based on the existing literature, with some small adaptation to better fit the standards landscape in the Peruvian asparagus sector. Codron et al. (2005) and Henson and Humphrey (2010) categorize private standards according to the vertical scope or the extension along the value chain. In line with this, we distinguish between pre-farm gate or production standards, focussing on agricultural production, and post-farm gate or processing standards, focussing on processing, handeling and distribution. The same authors also distinguish between baseline or low-level standard schemes and premium or high-level schemes. The latter are designed to establish superior attributes and differentiate products, while the former are not designed to establish the uniqueness of particular products but aimed at meeting required minimum levels of performance. We take a slightly different approach and classify low- and high-level standards according to the stringency of the requirements, as stated by the surveyed companies. Export companies perceive GAP, SQF, HACCP and GMP as low-level standards because they entail lower requirements and demand less company investments. Global Gap, TESCO, LEAF, BRC and IFS are perceived as high-level standards due to the larger time, physical, as well as human capital (e.g., training) investments they need. BASC certification, mainly required by the US, is classified as a separate standard, due to its intrinsic aim of promoting safe international trade and protecting from bioterrorism and drug trafficking.

The figures in Table 1 reveal that, while the first private standards in the sector were processing standards, production standards spread more rapidly during the early years 2000s. By 2006, 44% of the sampled export companies had at least one production certificate and nearly 24% a processing certificate. The spread of processing standards increased further to 25% in 2011 while the spread of production standards decreased over time, to 35% in 2011. The spread of production standards mainly concerns high-level standards, in particular Global Gap. The overall raise of processing standards over time is first due to low-level certifications (in 2006) and then to high level certifications (2011), and results are mainly driven by the two main low and high-level types of certifications, i.e. HACCP and BRC. Companies can either choose to directly adopt high-level standards, or to first adopt lower standards and then to upgrade to higher standards.



Note: Population of 567 export firms over 1996-2011
Source: Author's calculation based on survey data

Fig. 3. Share of exported asparagus sourced from all external producers and from small producers (⩽10 ha) for the period 1996–2011; for the population of 567 export firms.

Sourcing strategies

The exported fresh asparagus is either produced by the export companies themselves (own supply) on owned or rented land[5] or sourced from external producers – or a combination of both. Fig. 3 shows that, in the period 1996–2011, the share of produce that was sourced from external producers decreased over time. In the late 1990s, 50–60% of the total export volume was sourced from external producers, while by 2011 this figure had dropped to 35%. This downward trend might be related to a new agricultural promotion law that was introduced in 2000. This law provided asparagus exporters with tax advantages and lower cost burdens on hired employees,[6]

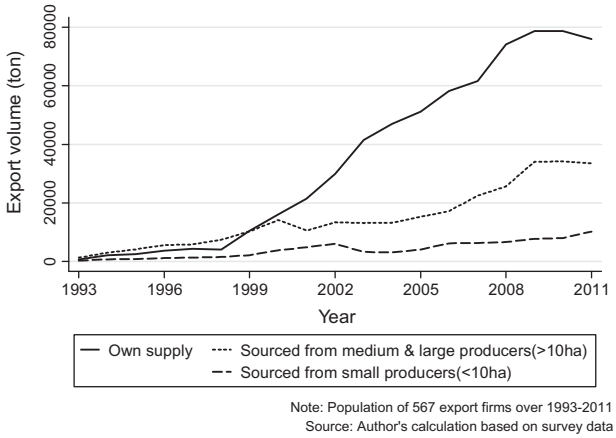
[5] Ninety percent of the companies with own primary production of asparagus own the cultivated land, while only 10% is renting in land for asparagus production. This is mainly due to the large land availabilities in the Peruvian coastal areas where asparagus is produced.
[6] Ley de Promoción del Sector Agrario – Ley No. 27360.

and made own production on owned or rented land more interesting.

The external asparagus producers are not a homogenous group of farmers, and we can make a distinction between small and large producers. The farm size of asparagus producers who are not directly exporting varies between 1 and 200 hectares (ha). In their 2005 census, the *Peruvian Institute of Asparagus and Horticultural Goods* (IPEH) estimated that at the national level there are around 1576 asparagus producers, of which 82% or 1300 producers are small producers with less than 10 ha of asparagus land. The remaining 276 are large producers cultivating between 11 and 50 ha (11.29%), between 51 and 100 ha (3.24%) or more than 100 ha (2.98%).[7] Small producers with only few and little asparagus plots are very different from large producers managing tens or even hundreds of hectares. The former are highly informal, heavily rely on family and informal labor input, use traditional production techniques, and frequently plant asparagus as cash and export crop next to crops for the local market and for own consumption. The latter are often registered farms, participating in formal labor markets, adopting modern inputs and technologies, and operating in a business oriented manner. Around 80% of all sourcing relationships between export companies and producers rely on agreements in which quantities, deadlines and reference prices are mentioned. While written contracts exist between export companies and larger farmers, oral agreement are very common in sourcing relationships with small producers. For the remainder of the analysis we distinguish between small producers with 10 ha or less and large producers with more than 10 ha.[8] Fig. 3 shows that in more recent years, about 6% of the total volume of exported asparagus are sourced from small producers while in the late 1990s this was 10–15%.

A decreasing share of export produce that is sourced from external producers, and from small producers in particular, does not necessarily mean that the absolute volumes of sourced produce are decreasing as well, given a very sharp increase in total export volumes. In Fig. 4, we look at the total volume of exported produce from exporters' own supply and the volume that is sourced from small or medium and large producers. The figure shows that the sharp export growth since the early years 2000s has mainly been driven by an increase in vertically integrated production by export companies themselves. However, also the total volume of export produce sourced from medium and large external producers has increased, be it at a lower and slightly more irregular pace. The quantity sourced from small producers has increased as well but at a much lower pace.

In order to better interpret the above graphs and the forces driving companies to adopt a certain sourcing strategy, in Table 2 we summarize companies' answers on an open question asking for the reasons behind their sourcing strategy. More than one fourth of all companies declare that the main reason for producing their own asparagus is to assure a certain quality of the exported good, while almost 17% mention the production of constant volumes which guarantees a continuous export flow. Another 10% of all companies has had or fears for negative experiences with external producers, in particular concerning eventual disloyal behaviors or contract breaching. Other reasons mentioned, include a lower work burden, a better traceability and higher formality or an increased cost efficiency and easier programming. Some other companies see own production as a first starting point in the export business or as a way of being more independent. Out of the companies sourcing from external producers, nearly 23% state that they are bound to do so due to lacking capital to invest in own fields or



Note: Population of 567 export firms over 1993-2011
Source: Author's calculation based on survey data

Fig. 4. Volume of exported asparagus sourced from own supply, from small producers (<10 ha) and from medium and large producers (>10 ha) for the period 1993–2011; for the population of 567 export firms.

technologies, 15% mention their need to satisfy their buyers with sufficient produce and around 10% their lacking experience in the production business. Minor reasons forcing companies to source from other producers are water limitations, plague on own fields or the political instability. Another – smaller – group of companies seems to explicitly choose to source at least part of their export volumes from external producers in order to more flexibly manage their exports (mentioned by almost 19% of all companies), to support small producers' businesses (8%), to fill their processing plant capacity (6%) or diversify their export portfolio (4%). Minor reasons mentioned in this case were the focus on a different firm activity, risk managing or learning strategies.

An increase of the importance of certification to private food standards has an effect on both the required quality and the cost structure of the companies, (i.e., requiring higher fixed and variable capital investments), which were both mentioned as main factors driving companies to opt for a certain procurement system. We could thus expect that certification, provided that companies have the financial capacities, could lead them to choose a more vertically integrated production structure. In the next sub-section we will explore whether there exists some descriptive evidence for a correlation between sourcing strategies and certification to private food standards.

Certification and sourcing strategies

Fig. 5 shows, for our 87 sampled companies, the evolution of sourcing strategies of certified and non-certified companies. Until 1998 none of the companies was certified and the average share of produce sourced from external producers was around 60%. When certification starts to play a role in the Peruvian asparagus export market we notice a divergence in the sourcing trends between certified and non-certified companies. After a period of adaptation between 1998 and 2005, certified companies sourced on average 20% of produce from external producers while non-certified companies sourced on average between 60% and 80% of produce.

In order to shed more light on the link between the adoption of private standards and firm's sourcing strategy, Fig. 6 shows the evolution of the average share of produce sourced from external and small producers for certified firms before and after the first year of certification. The decrease of the average percent sourced from both all producers and small producers in the year of certification is striking. The percentage sourced from all types of producers increases again after two years, but never reaches the levels

[7] II Censo Nacional de Productores de Espárragos – IPEH.

[8] N.B. in this paper we are explicitly dealing with export crop producers, which have been shown not to be among the poorest and smallest farmers, but to be among an already selected group of the better-off farmers (Maertens and Swinnen, 2007).

Table 2
Reasons for exporters to rely on own supply or source from external producers. *Source:* Authors' calculation based on survey data.

Companies relying on own supply of asparagus ($N = 58$)[a]		Companies relying on sourcing asparagus from external producers ($N = 76$)[b]	
Reasons for relying in own supply	Percentage[c]	Reasons for relying on sourcing from external producers	Percentage[c]
Guaranteed quality	27.08	Lack of capital	22.92
Guaranteed volumes	16.67	Higher flexibility	18.75
Bad experience with sourcing/contract breaching	10.42	Need to satisfy buyers	14.58
Lower work burden	8.33	Lack of experience	10.42
Traceability of produce	8.33	Support small producers	8.33
Cost efficiency	6.25	Fill processing plant capacity	6.25
Higher formality	6.25	Diversify production	4.17
Start-up strategy	6.25	Water limitation	2.08
Easier programming/monitoring	4.17	Political instability	2.08
Independence	4.17	Asparagus is not the core activity	2.08
Main external producer dropped them	2.08	Plague in own fields	2.08
		First learning with others' produce	2.08
		Reduce risks	2.08

[a] This includes all companies that ever used own supply, and includes 35 companies who use(d) both own supply and sourcing from external producers.
[b] This includes all companies that ever sourced from external producers, and includes 35 companies who use(d) both own supply and sourcing from external producers.
[c] Sampling weights are used to calculate percentages.

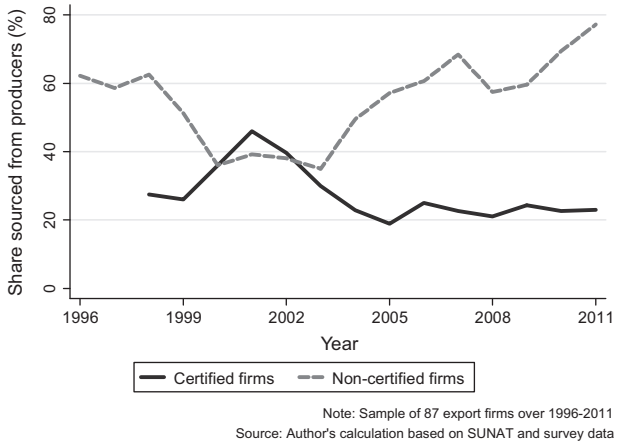


Fig. 5. Evolution of the average share of produce sourced from all external producers by certified and non-certified firms for the period 1996–2011; for the sample of 87 surveyed export firms.

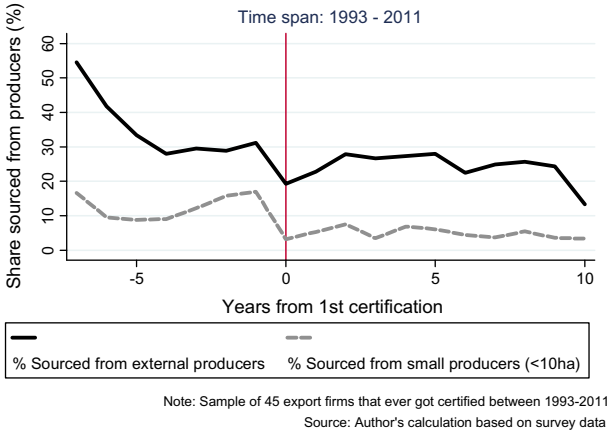


Fig. 6. Evolution of the average share of produce sourced from all external and from small producers (<10 ha) before and after the first year of certification (year 0); for a sample of 45 surveyed export firms that ever got certified between 1993 and 2011.

previous to certification (average of 35% previous to certification as compared to a 24% after certification), while the percentage sourced from small producers remains relatively constant below the 10% threshold. Since the first year of certification differs across companies, the observed decrease in external sourcing around the year of certification points to changes in companies' sourcing strategy that are closely linked to certification.

Company characteristics

In Table 3 we describe the characteristics of asparagus export companies. We distinguish between time varying, i.e., changing from one year to another, and time constant characteristics and show summary statistics for the variables that will be used in further analyses. We again report descriptive statistics for the years 2001, 2006 and 2011.

In 2001 export volumes are larger for non-certified than for certified companies, but this trend is reversed in 2006 and 2011, when certified companies export significantly larger volumes than non-certified companies.[9] Mainly green asparagus are exported from Peru but the small share of white asparagus in total exports, mainly comes from certified companies. The probability of owning asparagus land or a processing plant and the size of the cultivated land are higher for certified than for non-certified companies across the three years. Certified companies are relatively older, especially in 2011, and more frequently owned by foreign and non-agricultural capital. In addition, the number of companies exporting under two distinct company names was slightly higher for non-certified companies in 2001 and 2006, but this decreased substantially by 2011. The affiliation to a favorable governmental tax-paying regime is higher for certified companies in both 2006 and 2011, which indicates a higher formality among certified firms. Managerial or organizational changes do not considerably change over time and are not very different between certified and non-certified companies. Finally, the location of certified and non-certified companies changes slightly over time; while in 2001 non certified companies were more common in Ica and Ancash as compared to non-certified companies, this trend is reversed in 2011.

The descriptive statistics in this section show that since the raise of private standards in Peru at the start of the 2000s, there have been important time trends in the typology of adopted standards, in the nature of export companies and their sourcing strategies. Whether the decreasing time trend and the observed differences in sourcing behavior between certified and non-certified firms can be attributed to the effect of private certifications is still questionable. Confounding factors can influence both the decision to get certified and to reduce the dependency on external

[9] In Schuster and Maertens (2013) the relationship between certification to private food standards and export volumes is specifically addressed.

Table 3
Company characteristics, by certification – 2001, 2006 and 2011. *Source:* Authors' calculation based on survey data.

Variables	Description	Time varying	2001		2006		2011	
			Certified companies ($N = 2$)	Non certified companies ($N = 24$)	Certified companies ($N = 26$)	Non certified companies ($N = 23$)	Certified companies ($N = 34$)	Non certified companies ($N = 22$)
Export volume	Exported volume in metric tons (mt)	Yes	836.75(888.16)	1356.727(1622.74)	2156.717(2614.716)	689.23(837.19)	2664.22(4032.2)	828.12(1222.65)
Green asparagus	% Of green (with respect to white) asparagus exported	Yes	100(0.000)	93.847(20.977)	88.352(25.632)	90.409(26.818)	86.313(39.723)	99.038(5.222)
Asparagus land – dummy	=1 If owns a asparagus land	Yes	1(0.000)	0.417(0.506)	0.827(0.400)	0.186(0.377)	0.924(0.348)	0.327(0.381)
Asparagus land – ha	= Hectars of asparagus land cultivated by the company	Yes	39.2(0.000)	11.541(20.651)	32.474(45.108)	3.199(9.109)	52.860(86.337)	3.633(6.574)
Processing plant	=1 If owns a processing plant	Yes	1(0.000)	0.477(0.508)	0.778(0.436)	0.441(0.482)	0.846(0.462)	0.282(0.361)
Years since foundation	Number of years since foundation year	Yes	8 (1.061)	5.592(2.924)	8.707(4.365)	5.990(4.166)	13.106(6.056)	4.991(3.051)
Foreign capital	=1 If owned by foreign capital	Yes	0.5(0.531)	0.153(0.366)	0.455(0.522)	0.204(0.392)	0.443(0.636)	0.381(0.389)
Non agricultural capital	=1 If starting capital comes from non agric business	No	0.5(0.531)	0.229(0.427)	0.300(0.481)	0.032(0.172)	0.330(0.602)	0.175(0.305)
Double Tax ID	=1 If company exports with >1 tax ID number	Yes	0(0.000)	0.08(0.275)	0.067(0.262)	0.097(0.288)	0.028(0.212)	0(0.000)
Taxpayer Regime	=1 If affiliated to favored taxpayer regime	Yes	0(0.000)	0(0.000)	0.300(0.481)	0(0.000)	0.346(0.609)	0.034(0.146)
Agriculture core business	=1 If agriculture is the core business	No	0.5(0.531)	0.576(0.502)	0.622(0.509)	0.429(0.481)	0.591(0.629)	0.312(0.371)
Management change	= If company experiences a change in the management	Yes	0(0.000)	0.0382(0.195)	0.100(0.315)	0.14(0.337)	0.028(0.221)	0.091(0.232)
Organizational change	=1 If company experiences an internal organizational change	Yes	0(0.000)	0.04(0.199)	0.149(0.375)	0.100(0.291)	0.028(0.221)	0.027(0.131)
Ancash	=1 If company operates in the Ancash region	No	0(0.000)	0.118(0.328)	0.266(0.463)	0.107(0.301)	0.057(0.295)	0(0.000)
Ica	=1 If company operates in the Ica region	No	0.5(0.531)	0.691 (0.470)	0.534(0.523)	0.591(0.478)	0.641(0.614)	0.556(0.398)
La Libertad	=1 If company operates in La Libertad region	No	0(0.000)	0.076 (0.270)	0.134(0.357)	0.129(0.326)	0.246(0.551)	0.329(0.377)
Lima	= If company operates in the Lima region	No	0.5(0.531)	0.038 (0.195)	0.033(0.188)	0.172(0.367)	0.028(0.212)	0.115(0.255)

Means and standard deviations in parenthesis. All sample weights are weighted for the population average to control for the oversampling of consolidated and intermediate companies.

production. In the next sections we use several econometric methods to deal with this empirical question and discuss the estimation results.

Econometric approach

Model specification

Our main goal is to determine the causal effect of certification to private food standards on the sourcing strategy of export firms. We estimate regressions of the following type:

$$S_{it} = \beta_0 + \beta_1 C_{it} + \beta_2 X_{it} + D_t + v_i + u_{it} \quad (1)$$

where S_{it} is the proportion of asparagus sourced from an external producer by company i in year t or alternatively the proportion sourced from small producers. The key variable of interest in the model is certification of company i in year t (C_{it}). In order to take the multiplicity of certification types into account, C_{it} is alternatively defined as 1/ a dummy variable for certification (equaling one if company i is certified in year t), 2/ a vector of two dummy variables for certification to processing and production standards, 3/ a vector of four dummy variables for certification to a low- and

high-level production and processing standards, and 4/ a vector of four dummy variables for certification to the most important individual private standards in the Peruvian asparagus export sector (Global Gap, HACCP, BRC and BASC). The vector X_{it} is a large set of observable firm characteristics. These include variables related to the type and the size of companies, their experience, their assets, their access to capital, tax pay regimes, management changes, and their location. These variables are described in Table 2. The asparagus land size might be endogenous in the model; we therefore use lagged variables of land or explicitly deal with the potential endogeneity biases. Finally, year dummies D_t are included to control for common macro-economic effects, v_i is a time constant unobservable firm-specific effect and u_{it} is the time-varying error term.

Identification and estimation methods

The estimation of our model entails two major complications. First, our main independent variable of interest C_i is potentially endogenous. This endogeneity could arise from 1/ time constant unobserved company characteristics which can both be correlated with the company's sourcing and certification preferences, 2/ a feed-back reaction of past sourcing shocks or behaviors on the adoption of certification, and 3/ time and company specific unobservable shocks simultaneously affecting sourcing and certification decisions.

The panel nature of our data rather easily allows us to deal with the first source of endogeneity and to remove the time invariant unobserved firm characteristics (v_i) by including company fixed effects in the regression analysis. The demeaning operation does not however allow us to deal with the second potential source of endogeneity caused by a feed-back reaction. Such a reaction could be either due to an 'anticipation effect', i.e., a behavioral change of companies in reaction to future certification plans, or a 'response effect', i.e., the fact that firms seek certification in response to changes in pre-period sourcing strategies. Both would engender a correlation between the certification variable and the error term, which would lead to biased estimates from Eq. (1). An 'anticipation effect' would certainly lead to a downward bias of the estimated certification coefficients β_1. This is likely true for the 'response effect' as well if past negative shocks to sourcing positively affect the likelihood of certification. We test for the endogeneity and anticipation assumptions by including the lead of the certification variable as a additional regressor in Eq. (1) and by inverting the equation to analyze the effects of one- and two period lagged sourcing strategies on the decision of certification. Results are shown and discussed in Table B1 of Appendix.

Further, in order to exclude every type of endogeneity arising from feed-back reactions or simultaneity issues, we resort to the General Method of Moments (GMM) approach of Arellano and Bond, 1991. This approach deals with the above unobserved heterogeneity and endogeneity problems by combining a first difference transformation with an instrumental variable estimation strategy. The within transformation eliminates the fixed firm characteristics v_i, while, to get rid of the endogeneity problem, lagged levels of the explanatory variables are used as instruments in the first-differenced equation (Arellano and Bond, 1991; Bond, 2002). We are able to use this methodology on 70 companies that consecutively export fresh asparagus for an average of six time periods per company. For the choice of the instruments it is important to ascertain whether the explanatory variables are strictly exogenous, predetermined or endogenous, i.e. to respectively be independent or depend on past or current export performance. Only time dummies are treated as strictly exogenous, while certification variables, export volumes and the total cultivated asparagus land are treated as endogenous. All remaining firm-specific characteristics are assumed to be predetermined. We consider this to be the most reasonable assumption, as, except for the eventually simultaneous certification and quick adjustment of export volumes and land cultivation, the adaptation of other firm characteristics to changes in the sourcing strategy is not immediate.

Second, an additional complication relates to the non- linear nature of the dependent variable, corresponding to the proportion of produce sourced from external producers. This variable is necessarily bounded between zero and one, and standard linear estimation techniques might not provide accurate estimates, as the predicted values cannot be guaranteed to lie in the unit interval. This type of regression falls into the class of models known as general linear models (GLM). Papke and Wooldridge (1996) developed a fractional probit estimator by following a quasi-maximum likelihood approach.[10] This approach has been typically used to estimate fractional outcomes, but the need to control for firm fixed effects complicates the choice of an estimator. Unobservable firm effects cannot be conditioned out of the likelihood model by including firm dummies, as this approach would introduce an incidental parameter problem undermining the consistency of all covariates (Greene, 2004). Papke and Wooldridge (2008) propose a solution for balanced, but not for unbalanced panel datasets. Due to the frequent entry and exit of firms in our dataset, Papke and Wooldridge's (2008) approach cannot be used in our situation and the remaining existing literature has not yet convincingly come up with a solution.[11] In any case, an important shortcoming of all non-linear estimation approaches mentioned above is that they assume strictly exogenous covariates. Even if the strict exogeneity is conditional on v_i in case of the fractional response model for panel data, it would not allow us to get rid of eventual endogeneities due to feed-back or simultaneity in the certification and the sourcing strategy decisions.

We therefore use a linear approach to estimate Eq. (1) as it allows us to deal more effectively with issues of endogeneity and unobserved firm heterogeneity. Moreover, Papke and Wooldridge (2008) show that even if the linear approximation misses some of the nonlinear effects at more extreme values, it does a good job in estimating the average effects of interest. As additional check we only report results from the fractional probit estimator (GLM), as first used by Papke and Wooldridge (1996) and which corresponds to the non-linear counterpart of the simple OLS estimation methods.

Results and discussion

Certification to private food standard

In Table 4 we report regression results on the percentage of produce sourced from external producers in general, and in Table 5 on sourcing from small-scale producers in particular. Both tables include results from 1/ a simple OLS regression (column 1); 2/ a GLM regression in which we control for the non linearity of the dependent variable (column 2); 3/ a fixed effects model in which we control for unobserved company heterogeneity (column 3); and 4/ an Arellano-Bond GMM estimation in which we control for the potential endogeneous character of certification, export volume and total asparagus land (column 4). The number of observations drops in the fourth model, as some companies present export gaps. Test results for the null hypotheses of no second order autocorrelation of residuals and of the joint validity of all instruments for the difference GMM estimation (Hansen test – overidentification restrictions) are shown at the bottom of the tables. All tests

[10] A two-way tobit could have been an alternative in our case, but was found suboptimal as the two extreme values at zero and one are real observations and not a result of censoring.

[11] To the best of our knowledge, only Wooldridge (2010) has dealt with the issue in a recent working paper, but further empirical applications are scarce.

Table 4
Regression results – Dep var: Sourcing from all external producers.

	OLS (1)	GLM (2)	Fixed effects (3)	Difference GMM (4)
Certification	−0.319***	−0.263***	−0.061*	−0.202*
	(0.072)	(0.053)	(0.036)	(0.114)
Processing plant	0.041	0.021	0.071*	0.101**
	(0.062)	(0.058)	(0.040)	(0.041)
Lag (total asparagus land)	−0.002***	−0.003***	−0.002**	
	(0.001)	(0.001)	(0.001)	
Total asparagus land				−0.002*
				(0.001)
Foreign capital	−0.061	−0.039	−0.154***	−0.145*
	(0.067)	(0.054)	(0.042)	(0.079)
Green asparagus	0.003**	0.002**	0.003	−0.194
	(0.001)	(0.001)	(0.004)	(0.219)
Log (export volumes)	−0.018*	−0.018**	−0.008	0.013
	(0.009)	(0.008)	(0.009)	(0.015)
Years exporting	0.005	0.005	−0.009	−0.004
	(0.006)	(0.006)	(0.007)	(0.010)
Double tax ID	−0.117	−0.110	−0.036***	0.007
	(0.118)	(0.085)	(0.013)	(0.031)
Administrative change	−0.014	−0.026	−0.018	0.016
	(0.038)	(0.031)	(0.022)	(0.013)
Organizational change	−0.037	−0.053	0.022	−0.013
	(0.045)	(0.042)	(0.020)	(0.032)
Taxpayer regime	0.017	0.058	−0.012	0.048
	(0.044)	(0.043)	(0.035)	(0.103)
Agricultural core business	−0.386***	−0.323***		
	(0.058)	(0.036)		
Non agricultural starting capital	−0.135**	−0.117**		
	(0.057)	(0.052)		
Constant	0.867***		0.424	
	(0.173)		(0.347)	
Year dummies	Yes	Yes	Yes	Yes
Location dummies	Yes	Yes	–	–
R^2	0.57	–	0.529	–
N	485	485	485	391
Number of collapsed IV's	–	–	–	46
2nd order autocorrelation	–	–	–	0.745
Hansen difference test	–	–	–	0.869

Company cluster robust standard errors in parenthesis.
Average marginal effects (APE) are reported in column 2.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

are accepted at around or above the 10% significance level, which confirms the validity of the instruments used. In all regressions we control for the set of covariates described in Table 2.

Our main result is that certification to private standards changes companies sourcing strategies, and significantly reduces the share of produce they source from external suppliers in general and from small-scale suppliers in particular. We find significant negative effects of certification on external sourcing (Table 4) and on small-scale sourcing (Table 5) across the different estimation techniques. For small-scale sourcing, the estimated effects are around 11 percentage points and are quantitatively very similar across the models (Table 5). This might indicate that unobserved firm characteristics and simultaneity bias are not important in this case. For external sourcing, however, the magnitude of the estimated effects are quite different across the models. The estimated coefficient in the simple linear OLS model indicates an effect of 32 percentage points (column 1, Table 4) and the estimated average marginal effect in the GLM model indicates an effect of 26 percentage points (column 2, Table 4). These estimates are substantially larger than the estimates from the fixed effects model, resulting in an effect of 6 percentage points (column 3, Table 4). This indicates that simple OLS and GLM estimations overestimate the effect of certification because of unobserved firm characteristics. However, the results from the GMM estimation indicate an effect of 20 percentage points (column 4, Table 4), which is again larger than in the fixed effects estimation and which can be explained by anticipation or response effects that lead to a downward bias in the fixed effect estimation. We believe the GMM estimation gives quantitatively the most credible results as it accounts for different sources of endogeneity bias.

When comparing the results from the GMM estimations on external sourcing and on small-scale sourcing (columns 4, Tables 4 and 5), we find a large difference in the magnitude of the effect of certification. Given that the average sourcing from external producers across all companies and years is 54%, the GMM estimate of 20 percentage point reduction corresponds to an average decrease of 37% in sourcing from external producers. Likewise, the average sourcing from small-scale producers is 15% and the estimated effect for small-scale sourcing is 11 percentage points, corresponding to an average decrease of 73% in sourcing from small-scale producers. Hence, private standards reduce sourcing from small-scale producers by twice as much as sourcing from external producers in general.

These results are in line with the existing descriptive and qualitative evidence in the literature, that with increasing standards, a decreasing share of export products is sourced from small farmers (e.g. Gibbon, 2003; Maertens and Swinnen, 2009). The econometric results are also supported by the descriptive results from Sectoral

Table 5
Regression results – Dep var: Sourcing from small producers.

	OLS (1)	GLM (2)	Fixed effects (3)	Difference GMM (4)
Certification	−0.114**	−0.113**	−0.118**	−0.107**
	(0.048)	(0.045)	(0.049)	(0.048)
Processing plant	0.045	0.045	0.018	0.015
	(0.064)	(0.050)	(0.047)	(0.052)
Lag (Total asparagus land)	−0.001	−0.001*	−0.001	
	0.000	(0.001)	0.000	
Total asparagus land				−0.001
				(0.001)
Foreign capital	−0.062	−0.061	−0.207***	−0.163**
	(0.041)	(0.040)	(0.058)	(0.069)
Green asparagus	0	0.000	0.007	0.002
	(0.001)	(0.001)	(0.004)	(0.003)
Log (export volumes)	−0.01	−0.009	−0.008	0.001
	(0.010)	(0.007)	(0.009)	(0.013)
Years exporting	−0.006	−0.007	−0.006	−0.002
	(0.006)	(0.005)	(0.008)	(0.006)
Double tax ID	0.033	0.013	0.042**	0.089*
	(0.074)	(0.067)	(0.018)	(0.046)
Administrative change	−0.022	−0.024	−0.022	−0.009
	(0.033)	(0.029)	(0.019)	(0.018)
Organizational change	−0.053	−0.057	−0.016	−0.018
	(0.035)	(0.038)	(0.025)	(0.021)
Taxpayer regime	0.035	0.032	0.03	−0.01
	(0.046)	(0.064)	(0.043)	(0.094)
Agricultural core business	0.016	0.006		
	(0.052)	(0.046)		
Non agricultural starting capital	−0.108*	−0.115*		
	(0.059)	(0.070)		
Constant	0.31		−0.245	
	(0.226)		(0.397)	
Year dummies	Yes	Yes	Yes	Yes
Location dummies	Yes	Yes	–	–
R^2	0.495	–	0.514	–
N	485	485	485	391
Number of collapsed IV's	–	–	–	49
2nd Order autocorrelation	–	–	–	0.098
Hansen difference test	–	–	–	0.869

Company cluster robust standard errors in parenthesis.
Average marginal effects (APE) are reported in column 2.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

analysis that firms' strategies towards vertical integration are driven by quality and traceability requirements in more than one third of the cases (see Table 2). The negative effect of certification to private standards on external sourcing can be explained by an increased cost burden of export companies to monitor and control quality and other product attributes that might be difficult to verify with external producers. The small, informal and scattered nature of small producers makes supervision by the exporting company even more complex and costly, which explains the larger negative effect of certification on sourcing from small-scale farmers.

The R^2 of the OLS and FE models indicate that 50% of the variability is explained by the model. A main part of the variability is captured by location and time fixed effects, but the results in Tables 4 and 5 reveal that some other firm characteristics have an impact on firms' sourcing strategy as well. First, the ownership of a processing plant and of agricultural land affects companies sourcing strategies. In the fixed effects and GMM model the ownership of an asparagus processing plant has a positive and significant effect on the percentage sourced from external producers in general but not from small-scale producers. This might be related to the amortization of processing costs, which require firms to increase or at least maintain a certain level of processed volume and therefore to increase sourcing from medium and large producers. The (lagged) total asparagus land owned by a company has a robust negative, although small effect on sourcing: each hectare of land cultivated by the company, reduces the percentage of sourced product by around 0.1–0.3 percentage points. The effect is slightly smaller and less significant on smallholder sourcing, indicating that the sourcing from smallholders depends less on merely the amount of product that a company can produce on its own, but is related to a strategic diversification of the product procurement. This result is in line with a recent work by Henson et al. (2013) who find that sourcing from small producers facilitates the spread of risks and a better management of the demand.

Second, when the company is owned by foreign capital or when the starting capital is non-agricultural, companies source less from external producers in general and from small producers in particular. Foreign investors and companies that started their asparagus export activity with non-agricultural capital thus prefer to vertically integrate, but also have a preference for large producers. This is likely to be due to a weaker relationship with the local communities and therefore with – especially small – external producers.

Third, the total export volume has a negative effect on external sourcing while the share of green asparagus in the total volume has a positive effect. These effects are only significant for sourcing in general – and not for small-scale sourcing – and only in the OLS and GLS models. Total export volume might be highly correlated

with unobserved company characteristics, which can explain the dwindling of the effect in the fixed effects and GMM models, and the absence of a significant effect in the models on small-scale sourcing where unobserved effects are less important. The positive effect of green asparagus is likely to be related to a more cost-efficient and less technically demanding production system as compared to white asparagus that is produced only be a few large companies.

Production versus processing standards

In what follows we distinguish between different types of standards, considering the categorization of private standards laid down above (see Table 1). We estimate the impact of certification to production and processing standards and to high-level and low-level standards on companies sourcing from external producers in general and small producers in particular. The results of are reported in Tables 6 and 7 respectively and include results of OLS, GLM, fixed effects and GMM estimations. In these regression we control for the same set of covariates as in Tables 4 and 5 but we only report the results for the certification variables as the estimated coefficients for the other covariates are the same.

A first important result from Table 6 is that the negative effect of certification on external sourcing only holds for production standards and not for processing standards. In particular, we find that certification to production standards has a significant negative effect on external sourcing and on small-scale sourcing in all regression models while certification to processing standards has a positive effect on external sourcing and a negative effect on small-scale sourcing, albeit only significant in the fixed effects and/or GMM estimations. When considering the preferred GMM estimation, we find that certification to private production standards significantly decreases external sourcing by 24 percentage points (i.e., 44%), and small-scale sourcing by 9.2 percentage points (i.e., 61.3%); whereas certification to processing standards significantly increases external sourcing by 14 percentage points (i.e., 25%), but has no significant impact on sourcing from small-scale farmers.

The heterogeneous effects can be explained by the nature of different certification schemes. Production standards impose restrictions on the pre-farm gate treatment of a product and thus on the cultivation and harvesting procedures which are typically managed by producers themselves. The origin of a raw product and the control over the production stage therefore matters in this case, which translates into a negative effect on external sourcing. Companies reduce their external sourcing to more easily control the compliance with the quality and traceability requirements of the production standards. Processing standards impose restrictions on product handling, but do not interfere with the origin of the raw product. In order to amortize the costs related to the certification process, firms need large volumes and reliable supply of raw produce and might therefore increases sourcing from external producers. As compared to sourcing from medium and large producers, sourcing from small producers only provides limited volumes in more informal business relationships, which is likely less cost effective for creating a guaranteed supply; it is therefore not affected by processing standards. These findings are in line with the descriptive statistics of Sectoral analysis that companies vertically integrate to guarantee quality and traceability, but source from external producers to fill their own processing plant capacities (see Table 2). Also the fact that owning a processing plant has a significant positive effect on external sourcing (see Table 4) but not on small-scale sourcing (see Table 5) supports the findings here. A fixed cost in processing capacity positively affects sourcing from all, but small, producers.

In Table 7, we further distinguish between baseline and high-level standards. First, we find that the negative effect of production certification on external sourcing only holds for high-level production standards and not for baseline production standards. This result holds for all regression models and for sourcing from all types of external producers and from small-scale producers. Second, considering the preferred GMM estimator, we find that both baseline and high-level processing standards have no significant effect on sourcing from small-scale producer (column 4b) but they have opposing effects on sourcing from any type of external producer (column 4a). Baseline processing standards have a significant positive effect on external sourcing and the estimated effect of 27 percentage points is substantially larger than the estimated effect of processing certification overall that was estimated at 14 percentage points (see Table 6). High-level processing standards have a significant negative effect and decrease external sourcing by 17 percentage points. This indicates that firms increase their processed volumes by purchasing from medium and large scale producers in order to amortize the costs related to the certification process, but only if the processing requirements are not too stringent. As soon as processing certification reach a certain stringency

Table 6
Regression results – production versus processing certification.

	Dep Var: Sourcing from all producers				Dep Var: Sourcing from small producers			
	OLS (1a)	GLM (2a)	Fixed effect (3a)	Diff-GMM (4a)	OLS (1b)	GLM (2b)	Fixed effect (3b)	Diff-GMM (4b)
Production certification	−0.431***	−0.347***	−0.180***	−0.240**	−0.157***	−0.196***	−0.094**	−0.092**
	(0.071)	(0.050)	(0.057)	(0.111)	(0.038)	(0.042)	(0.036)	(0.044)
Processing certification	0.06	0.052	0.087*	0.141**	0.03	0.037	−0.077*	−0.043
	(0.044)	(0.042)	(0.051)	(0.069)	(0.049)	(0.046)	(0.043)	(0.067)
Company covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location dummies	Yes	–	–	–	Yes	–	–	–
R^2	0.614	–	0.516	–	0.111	–	0.222	–
N	485	485	485	391	485	485	485	391
No. of collapsed IV's	–	–	–	49	–	–	–	49
2nd order autocorrelation	–	–	–	0.857	–	–	–	0.098
Hansen Difference test	–	–	–	0.514	–	–	–	0.514

Company cluster robust standard errors in parenthesis.
Average marginal effects (APE) are reported in columns 2a and 2b.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

Table 7
Regression results – low versus high stringency certification.

	Dep Var: Sourcing from all producers				Dep Var: Sourcing from small producers			
	OLS (1a)	GLM (2a)	Fixed effect (3a)	Diff-GMM (4a)	OLS (1b)	GLM (2b)	Fixed effect (3b)	Diff-GMM (4b)
Production certification: baseline	−0.014	−0.070	0.026	0.021	−0.02	−0.639***	0.065	0.108
	(0.059)	(0.065)	(0.044)	(0.456)	(0.051)	(0.123)	(0.056)	(0.502)
Production certification: high level	−0.429***	−0.347***	−0.166***	−0.210**	−0.163***	−0.218***	−0.092**	−0.115**
	(0.070)	(0.049)	(0.054)	(0.104)	(0.040)	(0.052)	(0.035)	(0.055)
Processing certification: baseline	0.077	0.065	0.097	0.274*	0.037	0.054	−0.141**	−0.045
	(0.048)	(0.041)	(0.064)	(0.198)	(0.054)	(0.050)	(0.062)	(0.115)
Processing certification: high level	0.027	0.053	−0.025	−0.168*	−0.100**	−0.165**	0.005	0.014
	(0.061)	(0.055)	(0.037)	(0.088)	(0.146)	(0.083)	(0.024)	(0.079)
Company covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Location dummies	Yes	–	–	–	Yes	–	–	–
R2	0.614	–	0.521	–	0.116	–	0.247	–
N	485	485	485	391	485	485	485	391
No. of collapsed IV's	–	–	–	55	–	–	–	55
2nd order autocorrelation	–	–	–	0.912	–	–	–	0.925
Hansen Difference test	–	–	–	0.938	–	–	–	0.938

Company cluster robust standard errors in parenthesis.
Average marginal effects (APE) are reported in columns 2a and 2b.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

level, companies find it more convenient to vertically integrate, as the need of guaranteeing quality and traceability outweigh the requirements of filling the processing plant. The results in this section highlight the fact that private standards are not a homogeneous entity and that different standards have very different effects in supply chains. This issue of heterogeneity of private standards has largely been ignored in the existing empirical literature on the impact of private standards.

Individual certificates

In a final analysis, we consider individual standards and estimate the impact on sourcing from external producers and from small producers. In Table 8 we estimate the impact of the four most important certification schemes (certificates which at least 10% of firms comply to in 2011) and only report results from the preferred Difference GMM estimator. Again, we see that different certification schemes can have very different effects on companies sourcing strategy. Global Gap, the main production standard, significantly decreases external sourcing and sourcing from small farmers. The magnitude of the effects is similar to the magnitude of the overall effects of certification (Tables 4 and 5) and production certification (Table 6) – which might indicate that Global Gap certification drives the overall results. Global Gap reduces general external sourcing by 19 percentage points, corresponding to 36% reduced sourcing, and it reduces sourcing from small producers by almost twice as much, i.e., 68%. These findings are in line with studies that have specifically focused on the impact of Global Gap and reported decreased smallholder sourcing as a result of Global Gap certification (e.g., Graffham et al., 2007; Kleinwechter and Grethe, 2006; Lemeilleur, 2012; Subervie and Vagneron, 2013).

In addition, we find that the other most spread certificates have positive and negative effects on sourcing behavior of firms but results are only significant for all type of external producers

Table 8
Regression results – by individual certification.

	Dep Var: Sourcing from all producers Difference GMM (1d)	Dep Var: Sourcing from small producers Difference GMM (2d)
Global Gap certification	−0.191**	−0.084**
	(0.084)	(0.037)
HACCP certification	0.186*	0.064
	(0.112)	(0.090)
BRC certification	−0.145*	0.023
	(0.081)	(0.068)
BASC certification	−0.227**	0.048
	(0.098)	(0.063)
Company covariates	Yes	Yes
Year dummies	Yes	Yes
N	391	391
Number of collapsed IV's	61	61
2nd order autocorrelation	0.954	0.152
Hansen Difference test	0.481	0.295

Company cluster robust standard errors in parenthesis.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

and not for sourcing from small producers. The most spread (baseline) processing standard, HACCP, has a positive, effect on external sourcing from all types of suppliers while the coefficient on the most spread (high level) processing standard, BRC, has an opposite sign. This is in line with the results above that firms amortize the costs related to the certification process until the processing requirements become too stringent. BASC, a standard that is mainly required by the US to protect themselves from bioterrorism and drug trafficking, was not included in the analyses in Production versus processing standards because of its specific aim, but is adopted by a large share of companies. From the analysis in Table 8 it is clear that certification to BASC also significantly reduces sourcing from all types of producers, but not from small producers. Unless the certification requirements are thus relatively undemanding, certified companies explicitly change their sourcing behavior and vertically integrate in order to better monitor the entire value chain, but eventually keep some relationships with small producers to flexibly adjust to external demand fluctuations.

Conclusion

In this paper we analyzed the impact of private food standards on the exclusion or inclusion of independent large, medium and small farms in the export supply chains of developing countries. We have provided robust empirical evidence from the asparagus export sector in Peru and conclude that private standards in general reduce the share of produce that export companies source from external and small-scale producers, thereby leading to increased vertical integration. We believe that this is an important finding and that our study is among the first to provide quantitative evidence based on panel data methods on the impact of private standards on the structure of export supply chains. Given the large number of exporters in the Peruvian export sector and the availability of panel data, we were able to better control for dynamic effects, selection bias and unobserved heterogeneity and to more accurately estimate the impact of certification to private standard schemes on companies sourcing strategies.

While most studies looked at the issue of exclusive supply chains from the perspective of family farmers, we looked at the issue from the perspective of export companies. This perspective brings some important nuances in the debate. A first nuance is in relative versus absolute numbers. We have shown that the relative importance of all external producers and small farmers in export production has decreased over time (and we have attributed this decline to the impact of private standards) but that in absolute terms the export volume that is sourced from external and small farmers has continued to increase. A second nuance is in the form of vertical integration that private standards induce. This could be forward or downstream vertical integration by exporters into primary production but could also be backward or upstream vertical integration by farmers into export activities. We have only analyzed the sourcing behavior of companies after they started involving in export activities and find evidence of backward integration.

In addition, due to the availability of detailed survey data on companies' certification to private standards, we were able to distinguish heterogeneous effects of different types of private standards. We find that production standards and high-level standards increase vertically integrated production by export companies and decrease sourcing from external producers while processing standards and baseline standards reduce vertical integration and increase external sourcing. While some other studies focused on the impact of individual certification schemes, no previous studies have analyzed the effect of different standards in a systematic way.

We recognize that our case-study approach has limitations and that our findings do not necessarily hold in other cases. The availability of land in arid coastal areas in Peru, public investment in large irrigation schemes, favorable tax regimes for export companies and favorable labor laws for agro-export companies might be important factors in the trend towards increased vertical integration in the asparagus sector. Also the long history of the asparagus export sector and the fact that Peru already had an important market share for asparagus in the international market before private standards started to emerge and spread, might play a role. Effects of private standards on supply chains and the inclusion of small producers might be different in more recent sectors, such as African horticulture exports that boomed along with the rise in private standards. Accurate research on private standards and its effects on food supply chains in different developing countries and contexts is still needed. Moreover, in this paper we have not looked at standards addressing issues of broader social accountability, which are increasingly being adopted by export firms in developing countries. There is thus room for future research to focus on the emerging role of social-issue standards, especially in terms of labor market or environmental behavior effects.

Nevertheless, our findings – even if they would only hold in middle-income, relative land-abundant countries and in well-established export sectors – have important implications for public policy and private investment. Developing country governments, NGOs and other donors focus on the inclusion of smallholder farms in lucrative export supply chains as part of a pro-poor development policy. A common used strategy to increase smallholder participation in high-value export chains is to promote certification to private standards and to assist smallholder farmers and export companies to become certified. For example, the EU-funded *Pesticide Initiative Program* (PIP) in ACP countries (Jaud and Cadot, 2012) and the USAID-funded *Business and Market Expansion* (BAMEX) project in Madagascar (Bignebat and Vagneron, 2011; Subervie and Vagneron, 2013) assist exporters and farmers to comply with private standards from overseas buyers. It has been documented, for example in the lychee sector in Madagascar (Bignebat and Vagneron, 2011) and in the horticultural sector in Thailand (Kersting and Wollni, 2013), that a large share of farmers who became certified under such programs do not continue their certificates once financial support from the project stops. Given these observations, our results that certification to private standers reduces companies' sourcing from smallholder producers, put doubt on the policy and donor strategies to promote certification to private standards. Development programs that promote private certification and assist export firms and farmers with standards compliance might even result in increased exclusion of smallholder farmers from export chains and thereby defeat their own development goals.

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Table A1
List of food standards.

BASC	Business Alliance for Secure Commerce	http://www.wbasco.org/
BRC	British Retail Consortium	http://www.brc.org.uk
GAP	Good Agricultural Practice	http://www.ipeh.org/
Global Gap	Global Good Agricultural Practice	http://www.globalgap.org
GMP	Good Manufacturing Practices	http://www.gmp.com.pe/
HACCP	Hazard Analysis and Critical Control Point	http://www.haccpalliance.org/
IFS	International Food Standard	http://www.ifs-certification.com
Leaf	Linking Environment and Farming	http://www.leafuk.org/
SQF 1000	Safe Quality Food Institute 1000	http://www.sqfi.com/
SQF 2000	Safe Quality Food Institute 2000	http://www.sqfi.com/
Tesco	Tesco Nurture (Supermarket standard)	http://www.tesco.com/nurture/

Table B1
Endogeneity check.

Indep Var	Dep Variable				
	Percentage sourced from producers (1a)	(1b)	Certification (2)	Product certification (3)	Processing certification (4)
Certification	−0.090**				
		(0.040)			
F.Certification	0.042				
		(0.058)			
Production certification		−0.132**			
		(0.050)			
F.Production certification		0.009			
		(0.033)			
Processing certification		0.01			
		(0.025)			
F.Processing certification		0.023			
		(0.038)			
L.Sourcing			−0.067	−0.285**	0.04
			(0.193)	(0.127)	(0.134)
Constant	0.529	0.668*	3.646***	4.057***	2.125***
	(0.338)	(0.340)	(0.894)	(0.658)	(0.803)
Covariates	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
R^2	0.128	0.156	0.426	0.513	0.273
N	536	536	537	537	537

Company cluster robust standard errors in parenthesis.
*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

Appendix

Table A1.

Appendix

Both a potential 'anticipation effect', i.e., a behavioral change of companies in reaction to future certification plans, or a 'response effect', i.e., the fact that firms seek certification in response to changes in pre-period sourcing strategies would invalidate the results from Eq. (1) estimated with fixed effects. We decide to test for the endogeneity and anticipation assumptions by including the lead of the certification variable as a regressor in Eq. (1) and by inverting the equation to analyze the effects of one period lagged sourcing strategies on the decision of certification. Results are shown in Table A1. After conditioning on the other regressors and unobserved effects, we see that leads of the certification variables are never significant, which rules out an 'anticipation effect' of certification. The lagged sourcing strategy however shows a significant impact on the decision to seek certification to production standards. A negative past shocks to sourcing therefore positively affects the likelihood of certification, which indicates that the certification estimates from the fixed effects models in columns 2 are likely to be negatively biased. This calls for the use of a GMM estimator, eliminating firm heterogeneities by at the same time controlling for the endogeneity of certification (see Table B1).

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